DIRECT TESTIMONY OF
TOM A. BROOKMIRE
ON BEHALF OF
DOMINION ENERGY SOUTH CAROLINA, INC.
DOCKET NO. 2021-2-E

Q. PLEASE STATE YOUR NAME, BUSINESS ADDRESS, AND CURRENT POSITION.

A. My name is Tom A. Brookmire, and I am the Manager of Nuclear Fuel Procurement. My business address is Innsbrook Technical Center, 5000 Dominion Boulevard, Glen Allen, Virginia 23060.

Q. PLEASE BRIEFLY SUMMARIZE YOUR DUTIES WITH DOMINION ENERGY SOUTH CAROLINA, INC.

A. As of January 1, 2021, I am responsible for nuclear fuel procurement, fuel-related project management, and nuclear fuel price forecasting and budgeting used by Dominion Energy South Carolina, Inc. ("DESC" or "Company"), which operates in South Carolina.

Q. DESCRIBE YOUR EDUCATIONAL BACKGROUND AND YOUR BUSINESS EXPERIENCE.

A. I am a graduate of Virginia Tech with a Bachelor of Science degree in Nuclear Science (1983), and I received a master's degree in Engineering in Nuclear Engineering from the University of Virginia (1988). I am a registered professional engineer in the Commonwealth of Virginia.

I joined Virginia Electric and Power Company in 1983 and have worked since then in staff and management positions involving nuclear fuel. My current responsibilities include procurement of nuclear fuel and related services, nuclear fuel-related project management, and the projection of nuclear prices and related capital costs and expense rates.

Q. HAVE YOU PREVIOUSLY TESTIFIED BEFORE THE PUBLIC SERVICE COMMISSION OF SOUTH CAROLINA ("COMMISSION")?

A. No, I have not previously testified before this Commission. However, in my capacity as Manager of Nuclear Fuel Procurement, I have testified before the State of North Carolina Utilities Commission and the State Corporation Commission of Virginia on multiple occasions.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?

A. The purpose of my testimony is to explain the nuclear fuel purchasing process for DESC generation and discuss uranium prices for the Review Period and the near-term outlook.

NUCLEAR FUEL PURCHASING

Q. PLEASE DESCRIBE THE NUCLEAR FUEL CYCLE.

A. Uranium ore is the source of fuel used to generate electricity in nuclear reactors. Naturally occurring uranium primarily consists of two isotopes, 0.7% Uranium-235 and 99.3% Uranium-238. As depicted in Exhibit No. ___ (TAB-1), uranium must undergo a series of processes to produce a useable fuel before it can be used in a reactor for electricity generation. These processes are mining and milling, conversion, enrichment, and fabrication.

In the first stage, uranium is mined. Once the ore is mined, it is sent to a mill where it is crushed into smaller pieces and then introduced to a slurry in which a strong mixed solution is used to dissolve and extract the uranium. At this point in the mining and milling process, the uranium concentrate is then dried and commonly referred to as yellowcake but is also known as triuranium octoxide (“U_3O_8”).

In the next step of the process, known as conversion, U_3O_8 goes through a chemical process in which it is converted into uranium hexafluoride ("UF_6") which is an important chemical form for the isotopic separation process in which UF_6 is the feedstock.

The isotopic separation process is more commonly referred to as enrichment. Enrichment is a highly proprietary process usually conducted with sophisticated machinery called centrifuges that increase the percentage of U_{235} isotope from 0.7 percent to an amount that is needed to operate in the reactor, usually between 4% to no more than the allowable limit of 5%, or other percentages less than 5% dictated by the specific core design.

Once the UF_6 is enriched to the desired level, it is shipped to the fuel assembly fabricator. There, the fabricator converts the enriched UF_6 to uranium dioxide ("UO_2") powder which is then formed into pellets. This process, and the subsequent steps of inserting the fuel pellets into fuel rods and bundling the rods into fuel assemblies for use in nuclear reactors, is referred to as fuel assembly fabrication.

Q. PLEASE DESCRIBE HOW YOUR DEPARTMENT MAKES PURCHASING DECISIONS FOR NUCLEAR FUEL.

A. My Nuclear Fuel Procurement ("NFP") group uses the forecasted refueling schedule on a periodic basis to form the foundation for future planned nuclear fuel requirements. Once the nuclear fuel requirements planning is developed, the NFP group is primarily responsible for procuring the uranium and associated services that will, in plan, meet those requirements. When the actual core design is completed, a finalized set of fuel requirements is assembled that forms the basis for the final fuel order.

Q. ARE DESC'S CONTRACTS TO PURCHASE NUCLEAR FUEL NORMALLY SHORT-TERM OR LONG-TERM?

A. Due to the long lead time required to process uranium prior to being loaded in DESC's reactor, the Company's contracts are normally long-term contracts, with a term in excess of two years. Currently the Company has long-term commitments for uranium. conversion services, enrichment, and fabrication for V.C. Summer Unit One. During the Review Period, the NFP group monitored the nuclear fuel market on an ongoing basis and evaluated spot market opportunities from time to time that may supplement long-term contract supplies as appropriate. Included in the procurement process is the Company's contingency reserve. The nuclear fuel contingency reserve is designed to provide security of supply for future reactor requirements by mitigating potential market disruptions.

Q. WHAT ARE THE CURRENT MARKET CONDITIONS FOR THE FRONT-END COMPONENTS?

A. The nuclear fuel market softened considerably in the six- to seven-year period after the Japanese earthquake and tsunami impact on the Fukushima nuclear plant in 2011, and uranium, conversion, and enrichment markets all showed varying decreasing price trends in that period. Beyond the notable Fukushima related reduced demand impacts in Japan, Germany made a decision to permanently shut down eight reactors, there have been shut down decisions and announced closings of several U.S. reactors, and Chinese reactor startups have occurred at a somewhat slower pace than anticipated pre-Fukushima. There have also been some reductions in supply, but generally lagging the demand side reductions (*e.g.*, postponement and deferral of new mines and mine capacity expansions, some reduction in production in Kazakhstan, and the idling of a U.S.-based uranium conversion plant along with delays in planned increases in uranium enrichment capacity). Since 2018, however, there has been a gradual reduction of excess fuel inventory levels, and market prices for uranium and enrichment have increased somewhat. Market prices for conversion have increased significantly but prices at present for all three segments are relatively stable. Nevertheless, current market prices for uranium and enrichment are all below levels required for increasing supply through investment in new capacity or restart of capacity.

The price for conversion services has experienced significant upward price lift in the last three years due to production cuts in the US. Term and spot conversion prices have remained high due to concern over the lack of investment in new conversion production facilities, and the possibility for shortfalls in capacity longer-term, but are now relatively stable. Recent term conversion pricing may support restart of idled capacity and reduce some degree of future upward price risk.

The cost for enrichment services has increased slightly during the last few years, although prices in this market are still depressed and well below prices required for capacity expansion. There has been some uplift in term price due to some increasing interest in long-term enrichment services possibly related to the recent extension of the Russian Suspension Agreement resulting in lower quota levels for Russian supply into the U.S.

The price for uranium concentrates largely bottomed in 2017, and although term prices have remained relatively stable since then, spot prices have increased. Both spot and term prices remain well below prices required for restart of idled production or new mine investment.

The price trend in the U.S. domestic nuclear fuel fabrication continues to be difficult to measure because there is no active spot market, but the general consensus is that costs will continue to increase due to regulatory requirements, reduced competition, and new reactor demand both in the U.S. and abroad. Additionally, the parent companies for both U.S. nuclear fuel fabricators (Westinghouse Electric Corporation ("Westinghouse") and Framatome) have experienced financial distress, which is likely to put upward pressure on fabrication costs and nuclear fuel engineering services.

Calendar year 2020 saw no reactor restarts in Japan. Previously, in 2018, five reactors met new standards and were restarted, and six additional reactors received initial approval with another 12 applications submitted to restart. The timing and extent of other reactor restarts in Japan currently remains uncertain. China continues to have an aggressive nuclear energy program and continues to be a significant factor impacting supply and demand for uranium as they do not have significant indigenous sources of uranium. They have acquired or developed significant uranium production capacity outside of China (especially in Africa). They use their own indigenous sources for conversion and enrichment and are not significant players impacting global demand outside of China for these services. China currently has 49 reactors in operation, 16 plants under construction, and others in planning.

Q. PLEASE UPDATE THE COMMISSION WITH RESPECT TO DESC'S USE OF THE NUCLEAR FUEL ORIGINALLY PROCURED FOR V.C. SUMMER UNITS 2 AND 3.

A. As the Company has previously advised the Commission, DESC has already transferred to V.C. Summer Unit 1 inventory all of the nuclear fuel originally purchased for V.C. Summer Units 2 and 3. With the abandonment of Units 2 and 3, DESC recorded downward adjustments to reduce the carrying value of the fuel to market value.

Additionally, DESC is using a cost averaging methodology for V.C. Summer Nuclear Station reactor fuel. As part of this methodology, costs for converted nuclear fuel and enriched nuclear fuel previously designated for use in V.C. Summer Units 2 and 3 are blended with V.C. Summer Unit 1 nuclear fuel inventory costs to create an inventory pool from which new refueling batches are created. This transition began with nuclear fuel batch 28 which was loaded into the reactor during the Spring 2020 Refueling Outage. As a result of the adjustments of the value of the fuel originally purchased for Units 2 and 3 and the creation of an average cost inventory pool from which future batches will be drawn, the Company expects that its nuclear fuel expense will continue to be significantly reduced in the short term and that the volatility of individual refueling batches due to swings related to uranium commodity pricing and timing of purchases also will continue to be reduced.

CAMECO ARBITRATION UPDATE

Q. PLEASE UPDATE THE COMMISSION CONCERNING THE ARBITRATION INSTITUTED AGAINST THE COMPANY BY CAMECO, INC. IN 2018.

A. By way of background, in 2016, DESC was procuring UF_6 for use at V.C. Summer Nuclear Station pursuant to a long-term contract with Cameco. The contract provided that, if there was a reduction in the total quantity of electricity that the Company would generate at V.C. Summer, DESC had the right to elect to reduce the quantity of UF_6 it otherwise was planning to receive. As a result of the delays experienced with the construction of Units 2 and 3 at V.C. Summer, DESC initially exercised this right in 2016 to reduce its future deliveries of UF_6. Following the abandonment of the Units, DESC continued to exercise this right. On November 8, 2018, Cameco notified DESC that it disputed the Company's decision to reduce its UF_6 deliveries and, on December 29, 2018, elected to submit the dispute to binding arbitration as provided in the governing contract. Pursuant to an agreement between the parties, the tribunal bifurcated the proceeding into separate liability and damages phases.

At the time of the Company's last fuel proceeding, a hearing on liability was expected to take place in late October 2020; however, that hearing was later delayed by mutual agreement of the parties. On October 14, 2020, the parties agreed to temporarily suspend the arbitration proceedings, and, in mid-December 2020, the arbitration proceeding was withdrawn with prejudice, thus ending the dispute. The last delivery under the referenced Cameco contract (at the same reduced quantity as previously planned by DESC) was completed in December 2020 and the term of that contract ended on December 31, 2020. Because Cameco has other additional existing long-term contracts with the Company, Cameco's withdrawal of the dispute maintains a positive business relationship with the Company and favorably positions both parties going forward. Because the Cameco dispute was fully resolved during the Review Period, the Company does not plan to provide further updates on this matter in future fuel proceedings.

<u>LABOR COSTS AND NUCLEAR FUEL CAPITAL</u>

Q. WHAT IS DESC'S CURRENT TREATMENT OF LABOR COSTS WITH RESPECT TO NUCLEAR FUEL CAPITAL?

A. The Company historically has expensed all labor costs as incurred through O&M labor costs.

Q. IS IT APPROPRIATE FOR SOME LABOR COSTS TO BE DIRECTED TO NUCLEAR FUEL CAPITAL?

A. Yes; for the reasons I explain below, the Company believes it is appropriate to change this treatment and charge certain labor costs to nuclear fuel capital through a fuel capital batch account and seeks Commission approval to do so.

Q. UNDER THE COMPANY'S REQUEST, WHAT LABOR COSTS WOULD BE INCLUDED IN THE NUCLEAR FUEL CAPITAL AND RECOVERED THROUGH THE COMPANY'S FUEL FACTOR?

A. Consistent with the treatment applied to nuclear fuel by all other Dominion Energy regulated electric utilities, those internal labor costs incurred in support of design, analysis, and fabrication of nuclear fuel assemblies such as, but not strictly limited to, nuclear fuel procurement, nuclear core design, safety analysis, and fabrication surveillance and final receipt inspection, would be recovered through the Company's fuel factor. Conversely, labor costs not tied directly to the design, analysis, or fabrication, such as engineering labor costs for reactor operation support, plant fuel handling labor costs, attending general fuel-related industry meetings, regulatory fees, or industry lobbying expenses, would be excluded from the fuel factor and continue to be expensed through O&M labor costs.

Q. WHAT IS THE RATIONALE FOR THE COMPANY'S REQUEST TO INCLUDE CERTAIN LABOR COSTS AS PART OF NUCLEAR FUEL CAPITAL?

A. Slightly more than one-third of the nuclear fuel assemblies that make up the reactor core are discharged and replaced by a new "batch" of fuel assemblies every eighteen months. Unlike fossil fuels, nuclear fuel assemblies are a manufactured product that first requires extensive design and engineering, then fabrication, and delivery to the reactor site where they are used for typical periods of three to five years before being discharged. For more than one year in advance of delivery, there are internal and external costs incurred for engineering, as well as the material acquisition (uranium), chemical processing (conversion), U_{235} isotope changes (enrichment), and fuel assembly fabrication steps that result in the creation of a nuclear fuel batch. And to ensure security of supply and provide a base for predictable pricing, these later steps in the nuclear fuel process are often contracted for years in advance.

The costs associated with the conversion of raw fuel into a form that is usable in a nuclear reactor are varied and are not limited exclusively to the cost of raw fuel. Fabrication processing costs necessarily include the cost of engineering services associated with specifying the design of the fuel assemblies to be used in an upcoming reload batch. Similarly, the costs associated with ensuring the suitability of fabricated fuel for insertion into the reactor core include the costs associated with engineering design, engineering analyses, and other internal costs to ensure that the design and analytical results comply with established safety requirements. The newly designed batch of fuel assemblies includes a customized set of fabrication specifications including, but not limited to, uranium enrichment, burnable absorber content, rod and assembly power distribution, rod internal pressures, and fuel dimensions. These types of design and analysis parameters must take into account the irradiation history of the non-discharged (approximately two-thirds of the reactor core) irradiated fuel, the projected energy generation of the subsequent reactor core, and must ensure that the fabricated fuel will meet fuel design and established requirements for safety.

Considering that fabricated nuclear fuel can be purchased in a completed "turn-key" bundled fashion, meaning that the total costs for procurement, materials, engineering, and fabrication are included in the supplier's delivered price for each nuclear fuel assembly, then all of these costs would be allowable as a batch capital cost. The Federal Energy Regulatory Commission ("FERC") recognizes that the Company, like many U.S. utilities, completes many of the batch design and analysis steps itself to ensure greater cost control, as well as more control over security of supply. When, as in the latter case, the Company incurs some of these costs on its own and shares this responsibility with the fabrication supplier in lieu of the fabrication supplier performing all of these steps, such costs should correctly be included in the batch costs captured in FERC Account 120.1 and ultimately recovered through the fuel factor.

Q. WHEN DOES THE COMPANY PROPOSE THAT THIS CHANGE WOULD BECOME EFFECTIVE?

A. The Company is seeking approval to implement this change and start charging the applicable labor costs to fuel assembly batches as part of the 2021 reporting period that began on January 1, 2021. If the change is approved, a small amount of the labor costs would be recognized in fuel costs planned for a fuel batch to go into service later in the 2021 reporting period; however, the majority of these labor costs would not be recognized in fuel costs until later in the 2024 reporting period due to the manner in which the fuel batches are processed.

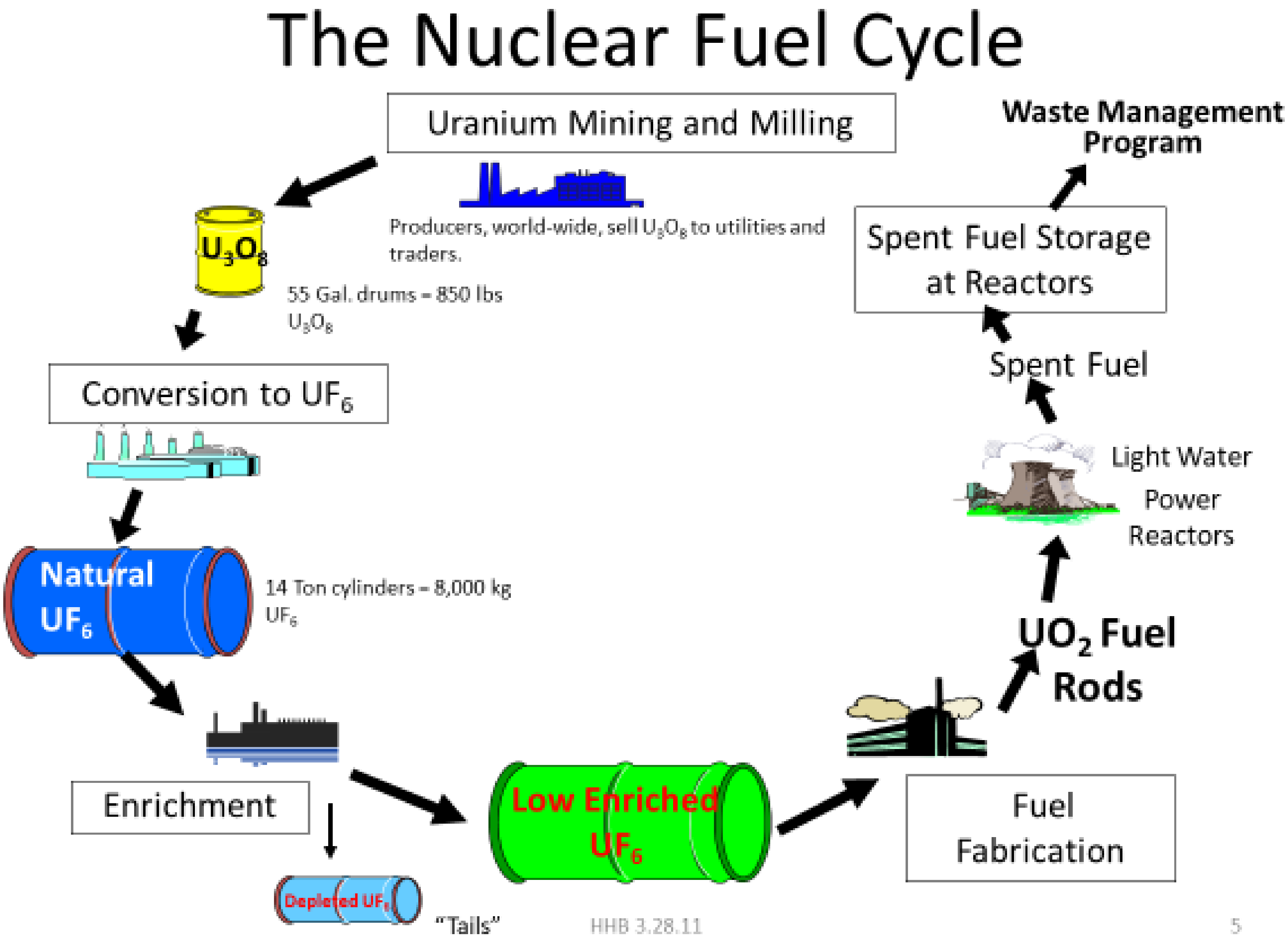
CONCLUSION

Q. WHAT REQUEST DOES THE COMPANY MAKE OF THE COMMISSION IN THIS PROCEEDING?

A. The Nuclear Fuel Procurement group made reasonable and prudent efforts to obtain market-based prices and reliable supply for its nuclear fuel requirements at VC Summer Unit 1. Therefore, on behalf of the Company, I respectfully request that the Commission find that the Company's fuel purchasing practices were reasonable and prudent for the Review Period. Further, the Company respectfully requests approval to include certain internal labor costs associated with the design, analysis, and fabrication of nuclear fuel assemblies as part of fuel batch capital on an ongoing basis beginning on January 1, 2021.

Q. DOES THIS CONCLUDE YOUR DIRECT TESTIMONY?

A. Yes.


The Nuclear Fuel Cycle
Uranium Mining and Milling
Producers, world-wide, sell U_3O_8 to utilities and traders.
U_3O_8
55 Gal. drums = 850 lbs U_3O_8
Conversion to UF_6
Natural UF_6
14 Ton cylinders = 8,000 kg UF_6
Enrichment
Depleted UF_6
"Tails"
Low Enriched UF_6
Fuel Fabrication
UO_2 Fuel Rods
Light Water Power Reactors
Spent Fuel
Spent Fuel Storage at Reactors
Waste Management Program
HHB 3.28.11
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